QuickStick™ Startup Delay

Purpose: This application note provides the worst case startup delay.

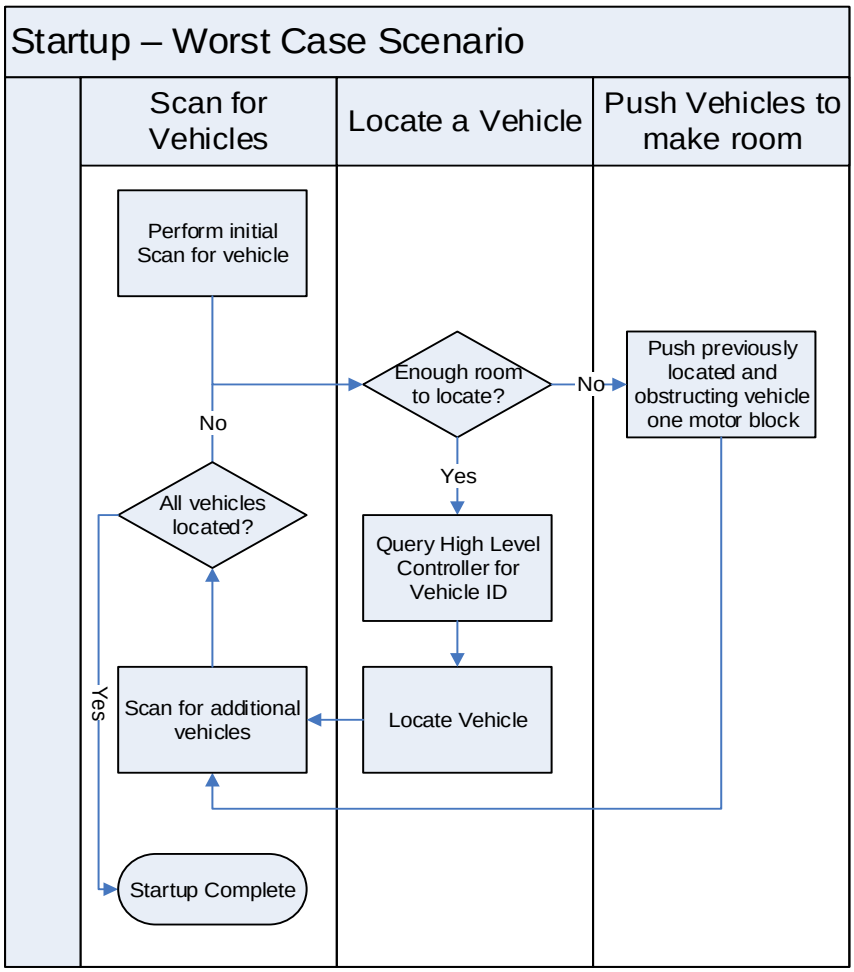
Introduction

The current implementation of the QuickStick software requires a vehicle to move for startup to complete. The startup process is used to locate a vehicle on the path and have a vehicle ID assigned for host identification.

Assumptions

1. All testing was done with vehicles on a straight path.
2. There is sufficient thrust to move the vehicles during the locate process.
3. The vehicles have been moved to the downstream most end of the path with no free blocks between them.
4. There is sufficient room on the path for all the vehicles to move and locate.
5. Locate process requires at least 1 unoccupied motor block to move into.
6. The vehicle length should not be a concern as the locate process just moves into the next motor block.
7. The system is tuned so there is no additional delay in moving the vehicle in the locate process.
8. The scan time of 3.85 milliseconds per motor block is based on a thirteen motor path with all half meter motors. For smaller paths, the scan time will be less. For example, on a two meter path with one-meter motors, the scan time is 1.5 milliseconds per motor block. In this document, the value of 3.85 milliseconds will be used.

Process Flow



Process Definitions

The "scan" reads the information from all the motors on a path. Based on test results, the scan time for QuickStick 100A motors is 3.85 milliseconds per motor block. This is the value that will be used so that the time can be estimated based on the length of the path.

The "locate vehicle" process will move the vehicle into the next available motor block. In the current implementation of startup, a one-second timer is started when the vehicle begins to move. After the one-second timer expires, the process will check to see if the vehicle has stopped moving. If the vehicle has not stopped, another one-second timer is started. Once the additional one-second timer expires, the process will check to see if the vehicle has stopped moving. If the vehicle has stopped then the scan for additional

vehicles will begin. In testing, the locate process takes two one-second intervals or two seconds per vehicle.

The "push" process is required for the vehicle to be located when there is no unoccupied block to move into. This will push a previously located vehicle one motor block (96 mm for QuickStick 100A). Depending on the number of vehicle remaining in the scan, this may occur multiple times. In the current implementation of startup, a one-second timer is started when the previously located vehicle begins to move. After the one-second timer expires, the process will check to see if the previously located vehicle has stopped moving. If the previously located vehicle has not stopped, another one-second timer is started. Once the additional one-second timer expires, the process will check to see if the previously located vehicle has stopped moving. If the previously located vehicle has stopped then the scan for additional vehicles to be located will begin. In testing, the push process takes one second per push. The number of pushes is related to the number of vehicles on the path.

The High Level Controller is queried for the next vehicle ID. This process takes thirty milliseconds based on our testing.

Variable Definition and Formula

S: Scan time = number of motor blocks multiplied by 3.85 milliseconds. Scan time is unique to each path and will need calculated based on the number of motor blocks.

L: Locate time = 2,000ms. This is a constant value, based on MagneMotion's laboratory testing.

H: High Level Controller Query = 30ms. This is a constant value, based on MagneMotion's laboratory testing.

P: Push time = 1,000ms. This is a constant value, based on MagneMotion's laboratory testing.

The number of pushes per vehicle to locate can be as much as one and a half times more than the number of located vehicles rounded up to the next whole number. In testing, we needed to locate three vehicles and had to perform five pushes.

NV: number of vehicles to locate on a single path.

NP: number of pushes (refer to Table 1)

NS: number of scans (refer to Table 1)

Therefore, the formula to determine the maximum startup time is as follows:
T = Maximum Startup Time = NV * (L+H) + NP * P + NS*S

Table 1 Number of Pushes and Scans based on the Number of Vehicles

Number of Vehicles	Number of Pushes	Number of Scans
1	0	2
2	2	6
3	5	10
4	10	16
5	16	23
6	24	32
7	33	42
8	44	54
9	56	67
10	70	82
11	85	98
12	102	116
13	120	135
14	140	156
15	161	178
16	184	202
17	208	227
18	234	254
19	261	282
20	290	312

Example Calculation

Given a path of 13 QuickStick 100A half-meter motors with 3 vehicles placed at the downstream end of the path such that no free blocks exist between vehicles, what is the maximum startup time?
First, a QuickStick 100A half-meter has 5 blocks. Therefore, scan time is as follows:
S = number of motor blocks * 3.85ms = (13 motors * 5 blocks per motor) * 3.85ms
S = 250.25ms

NV = number of vehicles = 3

NP = number of pushes = 5 (refer to Table 1 where NV = 3)

NS = number of scans = 10 (refer to Table 1 where NV = 3)

Therefore the maximum startup time is:
T = Maximum Startup Time = NV * (L+H) + NP * P + NS*S
T = 3*(2,000 + 30) + 5*1,000 + 10*250.25
T = 13,592.5ms

Precaution

Startup will first attempt to locate vehicles by moving them in the downstream direction. If there is not enough room to move vehicles in the downstream direction, the process will attempt to move vehicles in the upstream direction. The startup process will continue until all vehicles are located or there is no more room in the upstream direction. If there is not a sufficient amount of room, then the process will switch to the downstream direction, then upstream direction, then downstream direction. If after the fifth change in direction, there is not enough room to locate a vehicle, startup will fail.

More Information
MagneMotion website: www.magnemotion.com
Questions & Comments: http://www.magnemotion.com/about-magnemotion/contact.cfm